Proposed solutions 7b

1) a) $$E_x = -\frac{1}{k_{mn}^2} k_m k_p A \cos k_m x \sin k_n y \sin k_p z$$

$$E_y = -\frac{1}{k_{mn}^2} k_n k_p A \sin k_m x \cos k_n y \sin k_p z$$

$$E_z = A \sin k_m x \sin k_n y \cos k_p z$$

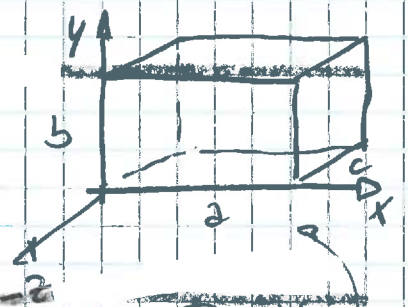
$$\cancel{H_x = \frac{j\omega\varepsilon}{k_{mn}^2} k_n A \sin k_m x \cos k_n y \cos k_p z}$$

$$H_y = -\frac{j\omega\varepsilon}{k_{mn}^2} k_m A \cos k_m x \sin k_n y \cos k_p z$$

$$H_z = 0$$

$m, n = 1, 2, 3, \dots$ $\quad p = 0, 1, 2, 3, \dots$

b)



(out of scale..)

$a = c = 2b$

For this system of coordinates the dominat mode is the TE_{101} mode

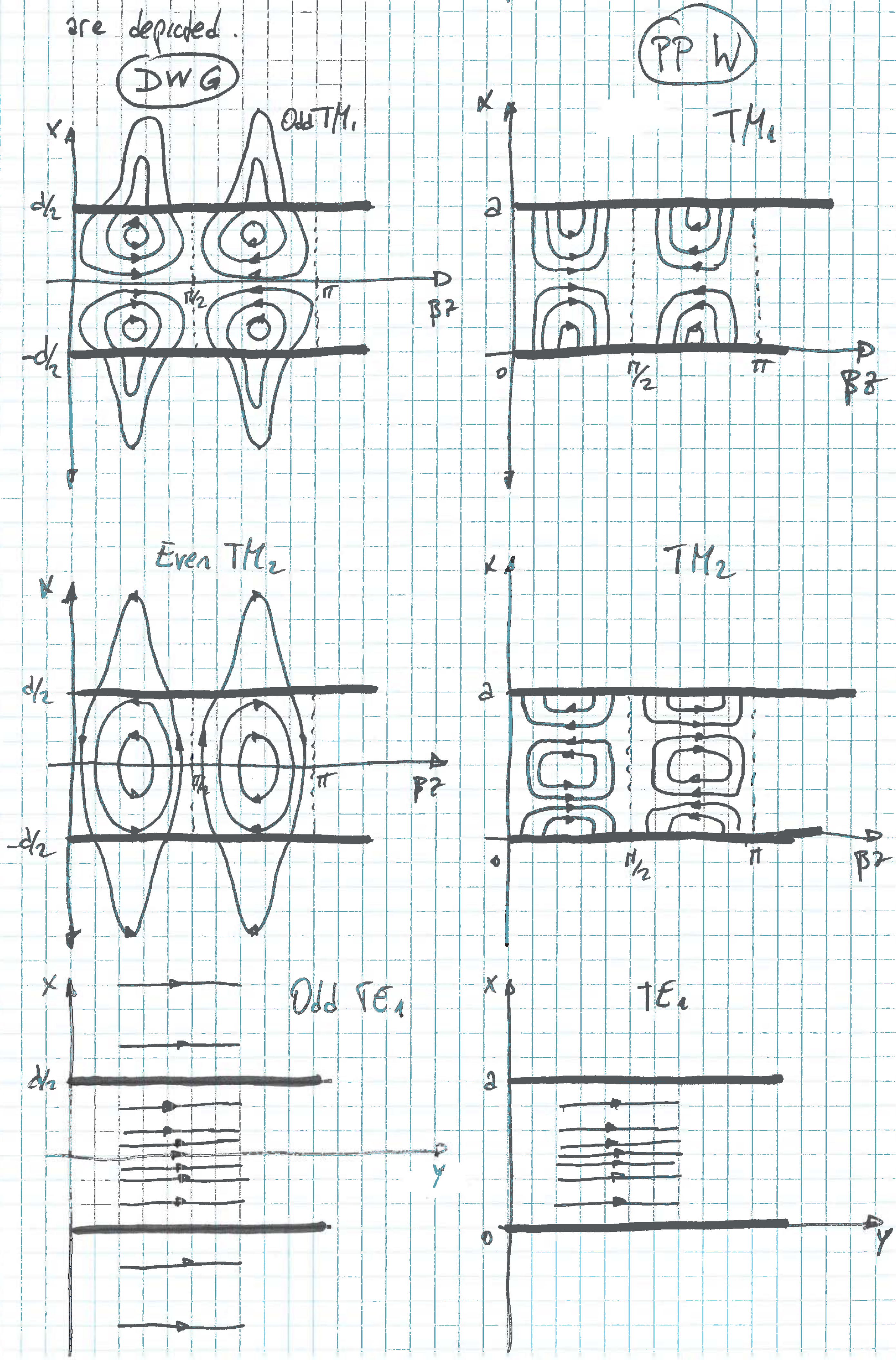
c) $$f_{101} = \frac{c}{\sqrt{\varepsilon_r}\, 2} \sqrt{\frac{2}{a^2}}$$

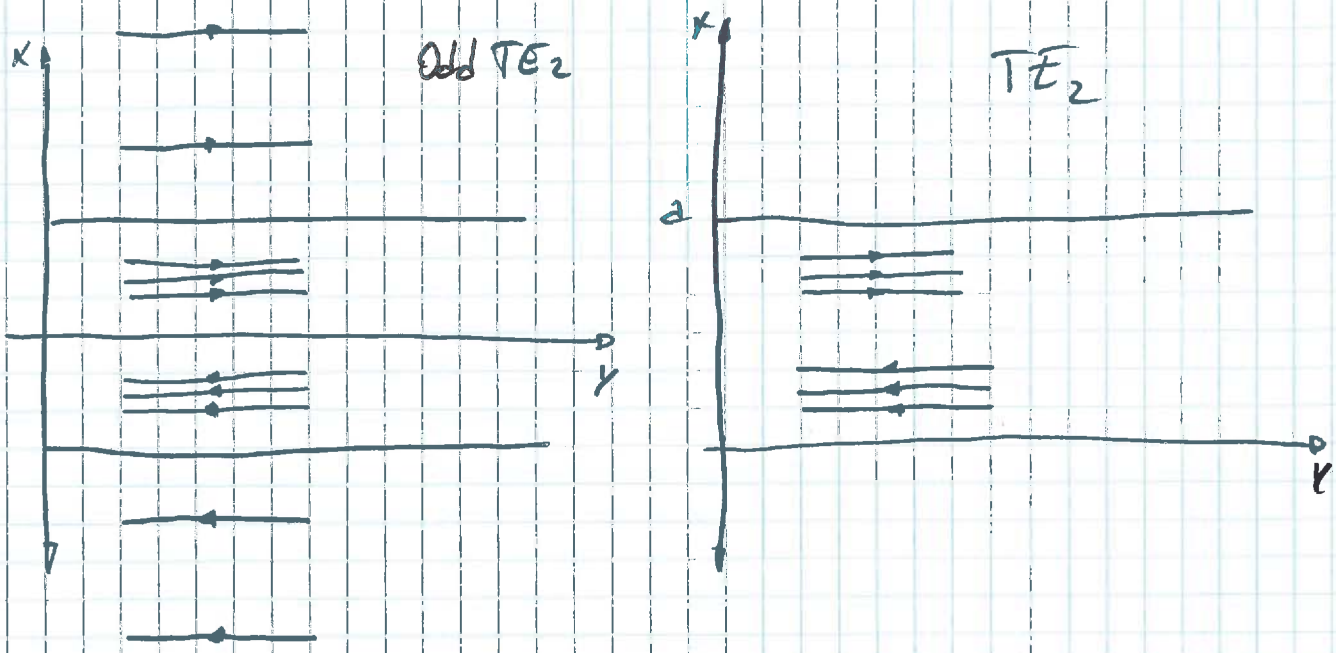
a) a=21.21cm

b) a=13.26 cm

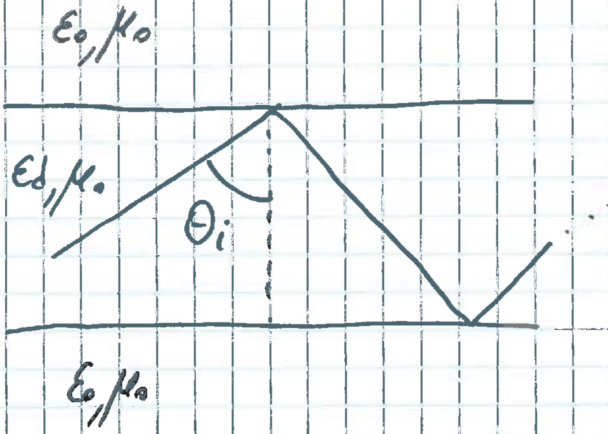
d) See the scan attached at the end

2) a) For the sake of a better comparison, only TM_1 and TM_2 are depicted.





b)



If θ_i is chosen such that $\theta_i \geq \theta_c$, then there is T.I.R. at the dielectric-air interface. Therefore, only inhomogeneous waves exist in air and the wave is "confined" $\Rightarrow$ can be guided

c) i) $f = \frac{c_1}{\lambda} = 187{,}5\ THz$

$$f_{cTM_m} = \frac{m-1}{2d\sqrt{\varepsilon_1\mu_1 - \varepsilon_2\mu_2}}$$

# of modes excited is maximum m such that

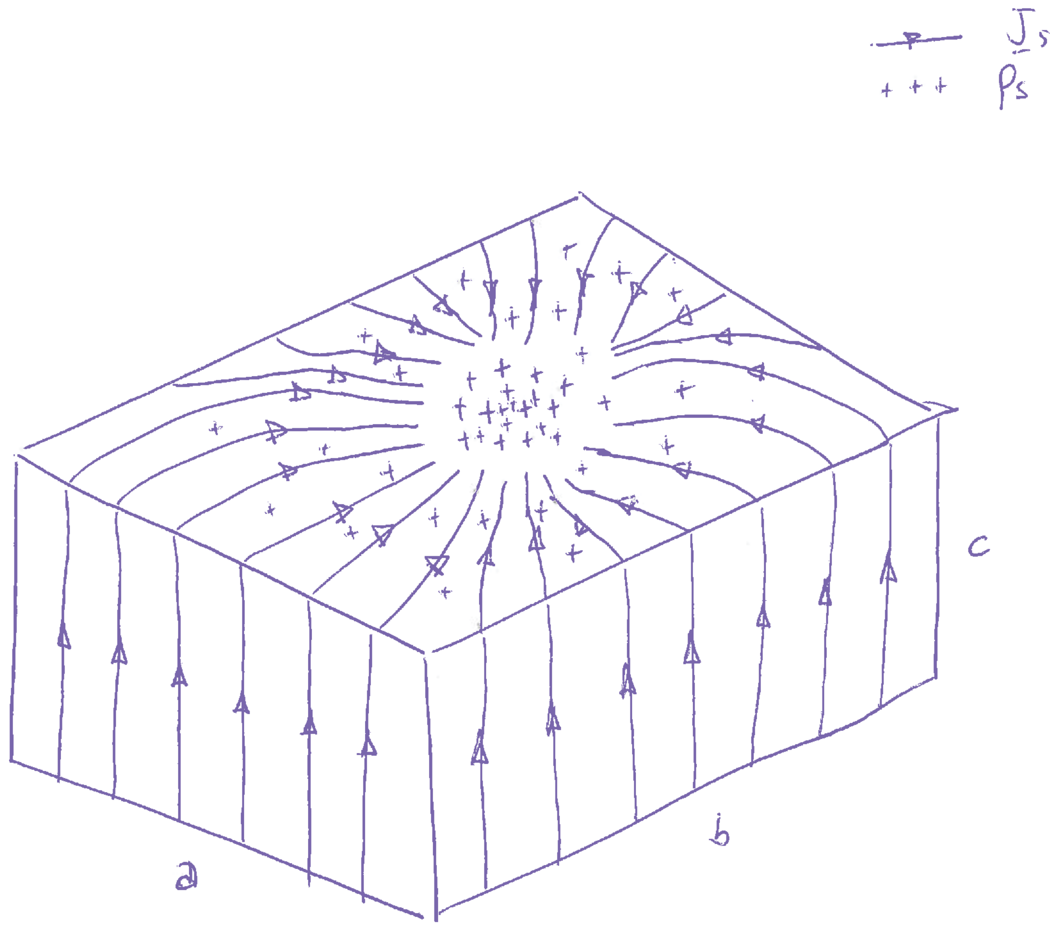
$$f_{cTM_{m_{max}}} < f$$

$$m_{max} < \lfloor f\, 2d\sqrt{\varepsilon_1\mu_1 - \varepsilon_2\mu_2} + 1 \rfloor = \boxed{7}$$

Since cutoffs freqs. for TE modes are the same, then the total amount of propagating modes is $\boxed{14}$

2) $\nexists$ d such that the DWG propagates only one mode

(TE and TM are always degenerate modes in a DWG)



(You can picture the bottom side and the hidden walls)